

WHAT IS CLAIMED IS:

1. An optical cross-connect apparatus for performing non-blocking optical cross-connection of  $n$  WDM input optical signals each containing  $m$  different wavelengths  $\lambda_1$  through  $\lambda_m$ , the apparatus comprising:

$n$  first wavelength converters for converting the  $m$  different wavelengths  $\lambda_1$  through  $\lambda_m$  contained in the WDM input optical signals into  $2m$  wavelengths  $\lambda_1$  through  $\lambda_{2m}$ ;

10 a first wavelength cross-connector for performing cross-connection according to wavelengths, the cross-connector including:

$n$  first demultiplexers for separating the optical signals wavelength-converted by the first wavelength converters into  $2m$  wavelengths, and

$n$  first multiplexers for combining optical signals with the  $2m$  separated wavelengths,

wherein same wavelengths should not be sent via each of bundles of  $2m/n$  lines by which the first demultiplexers and the first multiplexers are connected;

$n$  second wavelength converters for converting the  $2m$  wavelengths contained in the optical signals cross-connected by the first wavelength cross-connector into  $2m$  wavelengths;

25 a second wavelength cross-connector for performing cross-connection according to wavelengths, the cross-connector including:

n second demultiplexers for separating the optical signals wavelength-converted by the second wavelength converters into  $2m$  wavelengths, and

n second multiplexers for combining optical signals with the  $2m$  separated wavelengths,

wherein same wavelengths should not be sent via each of bundles of  $2m/n$  lines by which the second demultiplexers and the second multiplexers are connected; and

n third wavelength converters for converting the  $2m$  wavelengths  $\lambda_1$  through  $\lambda_{2m}$  contained in the optical signals cross-connected by the second wavelength cross-connector into  $m$  wavelengths  $\lambda_1$  through  $\lambda_m$  and for sending the  $m$  wavelengths  $\lambda_1$  through  $\lambda_m$ .

15

2. An optical cross-connect apparatus for performing non-blocking optical cross-connection of  $n$  WDM input optical signals each containing  $m$  different wavelengths  $\lambda_1$  through  $\lambda_m$ , the apparatus comprising:

n first wavelength converters for converting the  $m$  different wavelengths  $\lambda_1$  through  $\lambda_m$  contained in the WDM input optical signals into  $2m$  wavelengths  $\lambda_1$  through  $\lambda_{2m}$ ;

a first wavelength cross-connector for performing cross-connection according to wavelengths, the cross-connector including:

n first demultiplexers for separating the optical signals wavelength-converted by the first

wavelength converters into  $2m$  wavelengths, and

$2n$  first multiplexers for combining optical signals with  $m$  separated wavelengths,

wherein same wavelengths should not be sent  
5 via each of bundles of  $m/n$  lines by which the first demultiplexers and the first multiplexers are connected;

$2n$  second wavelength converters for converting the  $m$  wavelengths contained in the optical signals cross-connected by the first wavelength cross-connector into  $m$   
10 wavelengths;

a second wavelength cross-connector for performing cross-connection according to wavelengths, the cross-connector including:

$2n$  second demultiplexers for separating the  
15 optical signals wavelength-converted by the second wavelength converters into  $m$  wavelengths, and

$n$  second multiplexers for combining optical signals with the  $2m$  separated wavelengths,

wherein same wavelengths should not be sent  
20 via each of bundles of  $m/n$  lines by which the second demultiplexers and the second multiplexers are connected;  
and

$n$  third wavelength converters for converting the  $2m$  wavelengths  $\lambda_1$  through  $\lambda_{2m}$  contained in the optical  
25 signals cross-connected by the second wavelength cross-connector into  $m$  wavelengths  $\lambda_1$  through  $\lambda_m$  and for sending the  $m$  wavelengths  $\lambda_1$  through  $\lambda_m$ .

3. An optical cross-connect apparatus for performing non-blocking optical cross-connection of  $n$  WDM input optical signals each containing  $m$  different wavelengths  $\lambda_1$  through  $\lambda_m$ , the apparatus comprising:

$n$  first wavelength converters for converting the  $m$  different wavelengths  $\lambda_1$  through  $\lambda_m$  contained in the WDM input optical signals into  $(2m-1)$  wavelengths  $\lambda_1$  through  $\lambda_{2m-1}$ ;

a first wavelength cross-connector for performing cross-connection according to wavelengths, the cross-connector including:

$n$  first demultiplexers for separating the optical signals wavelength-converted by the first wavelength converters into  $(2m-1)$  wavelengths, and

$(2m-1)$  first multiplexers for combining optical signals with  $n$  separated wavelengths,

wherein each of the first demultiplexers is connected to each of the first multiplexers by one line;

$(2m-1)$  second wavelength converters for converting the  $n$  wavelengths contained in the optical signals cross-connected by the first wavelength cross-connector into  $n$  wavelengths;

a second wavelength cross-connector for performing cross-connection according to wavelengths, the cross-connector including:

$(2m-1)$  second demultiplexers for separating

the optical signals wavelength-converted by the second wavelength converters into  $n$  wavelengths, and

$n$  second multiplexers for combining optical signals with  $(2m-1)$  separated wavelengths,

5                wherein each of the second demultiplexers is connected to each of the second multiplexers by one line; and

$n$  third wavelength converters for converting the  $(2m-1)$  wavelengths  $\lambda_1$  through  $\lambda_{2m-1}$  contained in the optical signals cross-connected by the second wavelength cross-connector into  $m$  wavelengths  $\lambda_1$  through  $\lambda_m$  and for sending the  $m$  wavelengths  $\lambda_1$  through  $\lambda_m$ .

4. An optical cross-connect apparatus for performing non-blocking optical cross-connection of  $n$  WDM input optical signals each containing  $m$  different wavelengths  $\lambda_1$  through  $\lambda_m$ , the apparatus comprising:

$n$  input-side wavelength converters for converting the  $m$  different wavelengths  $\lambda_1$  through  $\lambda_m$  contained in the WDM input optical signals into  $mn$  wavelengths  $\lambda_1$  through  $\lambda_{mn}$ ;

a wavelength cross-connector for performing cross-connection according to wavelengths, the cross-connector including:

25                 $n$  demultiplexers for separating the optical signals wavelength-converted by the input-side wavelength converters into  $mn$  wavelengths, and

n multiplexers for combining optical signals  
with the mn separated wavelengths,

wherein same wavelengths should not be sent  
via each of bundles of m lines by which the demultiplexers  
5 and the multiplexers are connected; and

n output-side wavelength converters for converting  
the mn wavelengths  $\lambda_1$  through  $\lambda_{mn}$  contained in the optical  
signals cross-connected by the wavelength cross-connector  
into m wavelengths  $\lambda_1$  through  $\lambda_m$  and for sending the m  
10 wavelengths  $\lambda_1$  through  $\lambda_m$ .

5. An optical cross-connect apparatus for performing  
optical cross-connection of n WDM input optical signals  
each containing m different wavelengths  $\lambda_1$  through  $\lambda_m$ , the  
15 apparatus comprising:

n input-side wavelength converters for converting  
the m different wavelengths  $\lambda_1$  through  $\lambda_m$  contained in the  
WDM input optical signals into m wavelengths;

a wavelength cross-connector for performing cross-  
20 connection according to wavelengths, the cross-connector  
including:

n demultiplexers for separating the optical  
signals wavelength-converted by the input-side wavelength  
converters into m wavelengths, and

25 n multiplexers for combining optical signals  
with the m separated wavelengths; and

n output-side wavelength converters for converting

the  $m$  wavelengths contained in the optical signals cross-connected by the wavelength cross-connector into  $m$  wavelengths  $\lambda_1$  through  $\lambda_m$  and for sending the  $m$  wavelengths  $\lambda_1$  through  $\lambda_m$ .